

Pulp Mills Make More Males Skewing the Sex Ratio in Fish

The toxicity of discharges from some pulp mills has decreased due to changes in manufacturing processes. Yet effluent from cleaner mills can still contain compounds that cause measurable effects in wildlife, according to research by D. G. Joakim Larsson and Lars Förlin of Göteborg University, Sweden [EHP 110:739–742]. The pair present epidemiologic data that support a causal relationship between exposure to pulp mill effluent and male-biased sex ratios in fish that may be mediated by endocrine-disrupting substances in the effluent.

Endocrine disruptors are chemicals that interfere with the action of hormones produced by the endocrine glands. Hormones affected by endocrine disruptors can include androgens and estrogens, which are responsible for the development of male and female sex characteristics, respectively.

During the 1997–2000 study, the researchers studied broods of the viviparous eelpout (*Zoarces viviparus*), a small bottom-dwelling marine fish. Eelpout mate once a year in early autumn, and the mothers carry their young for about two months. Each fall, in late October to mid-November, eelpout embryos were collected near a kraft pulp mill on the Swedish Baltic coast that uses chlorine-free bleaching technology. Samples were taken at distances of 1.7–46.0 km from the mill. Prior to collection, the eelpout broods had been exposed to effluent during critical periods in embryonic sexual development.

In 1997, eelpout harvested 1.7 km from the mill were significantly male-biased (54.5% male) compared with the reference sites, where sex ratios were closer to 50/50. Samples taken farther from the mill had fewer males, with the male bias decreasing on a gradient as the distance from the mill increased. The pattern was similar in 1998 (57.8% and 53.9% male at the two sites closest to the mill).

Pulp production was stopped for 17 days in 1999 while the mill's facilities were modified to allow increased production. This shutdown coincided with the period when sexual differentiation usually occurs in eelpout embryos, a development that allowed Larsson and Förlin to test whether the skewed sex ratios previously found by the mill were associated with exposure to the effluent. Analysis of the broods from 1999 showed that the sex ratios of populations near the mill were normal. But by the following year, sex ratios were again male-biased (61.3% male).



You'd pout, too. Endocrine-disrupting chemicals in pulp mill discharge appear to contribute to higher numbers of male eelpout offspring.

The researchers also compared eelpout collected near the mill with those taken from sites near an oil refinery, a petrochemical-based factory, and a river polluted with heavy metals and organochlorines, as well as two sites with mixed exposures. Only the eelpout collected near the pulp mill had skewed sex ratios.

The Swedish research is consistent with a Canadian study in which mill effluent acted as an endocrine disruptor in white suckers (*Catostomus commersoni*). Those fish also reverted to a near-normal physiology during a mill shutdown. In both cases, the endocrine-disrupting effects were reversed in a relatively short time once exposure stopped.

Larsson and Förlin are working to identify specific endocrine disruptors in effluents from pulp and paper mills. They hope that results of this research will contribute to an evaluation of manufacturing processes to further reduce the effects of pulp mill effluents on the environment. —Kris S. Freeman

Reproduction Disruption Hydrocarbons May Affect Menstrual Cycle

Studies have shown that exposure to hydrocarbons in fuels and solvents can adversely affect fertility in both men and women. In this month's issue, researchers from the University of Cincinnati and the National Institute for Occupational Safety and Health dig deeper into this issue with an investigation designed to examine the potential effects of low-dose hydrocarbon exposure on endocrine production of reproductive hormones in women [EHP 110:805–811]. Their analysis uncovers a disturbing association between low-level hydrocarbon exposure and reduced concentrations of an endocrine hormone that plays a role in whether a woman's menstrual cycle is capable of supporting conception.

The investigators examined female U.S. Air Force personnel who had been exposed to fuel (primarily jet fuel) and solvents to varying degrees in the course of their military duties. A sample of 170 women completed detailed questionnaires about their work, health, and reproductive and menstrual histories, along with other pertinent information. Of these women, 100 also kept daily diaries documenting two consecutive menstrual cycles, including chemical and physical exposures during that time, and urine sample collection data.

Daily first morning urine samples were analyzed for the presence of four key urinary endocrine markers that have been associated with nonconceptive menstrual cycles: lower preovulatory luteinizing hormone (LH), lower mid-luteal-phase pregnanediol 3-glucuronide and estrone 3-glucuronide, and higher follicle-phase pregnanediol 3-glucuronide. The researchers also collected exhaled breath samples from 63 of the participants, which allowed a more sensitive measurement of low-dose exposure to hydrocarbons than blood or urine sample analysis. This was a one-time sample collection performed during the initial interview, an average of 1.4 hours after the women had left their work sites. The researchers analyzed the breath samples to estimate internal doses of the two groups of hydrocarbons found in fuels and solvents: aliphatic hydrocarbons (such as hexane and octane) and aromatic hydrocarbons (such as benzene and toluene).

The major discovery was that preovulatory LH concentrations in urine were significantly lower in the women who had higher internal doses of aliphatic hydrocarbons. The investigators are careful to note that

it is unclear whether those lowered LH concentrations were low enough to affect conception, and that their study was not designed to address that question. However, as they explain, LH controls the secretion of sex hormones in both sexes and is essential for ovulation and luteinization (a key step in the ovulatory process). As such, they write, “if [hydrocarbon] exposures chronically alter LH levels, this effect could impact LH-dependent processes and thereby compromise reproduction.”

The researchers suggest that their findings need to be confirmed in future studies designed to detect the possible effects of aliphatic hydrocarbon exposure on the ability to conceive and maintain pregnancy. Although the study population in this case was at a greater risk of exposure to these compounds than the general population, most everyone comes into contact with them at one time or another in the course of activities as routine as refueling an automobile. As such, the implication that exposure to aliphatic hydrocarbons could adversely affect conception is of wide concern, and warrants further investigation.

—Ernie Hood

Pediatrician Prescription

More Environmental Training Needed

The importance of environmental exposures to children’s health is well known to pediatricians, but they need more training in that area, according to a recent survey by Emory University researchers [*EHP* 110:823–827]. “There’s a disparity between what pediatricians feel is important and what they feel equipped to handle,” says coauthor Howard Frumkin. The survey of more than 250 randomly selected pediatricians in the state of Georgia found that, although less than one-fifth of pediatricians are trained in taking environmental histories, most believe data on environmental exposures are important for monitoring and maintaining children’s health. More than half of the doctors surveyed report encountering a child who had been seriously and adversely affected by an environmental exposure.

The Emory team examined the pediatricians’ attitudes, beliefs, and practices regarding children’s environmental health by mail questionnaire. The team surveyed mainly private primary care pediatricians. Of those selected, roughly two-thirds practice in urban settings, one-third in rural areas.

According to the report, although interest in environmental health education may be high, training remains a low priority. The article cites recent studies revealing that one-quarter of medical schools offer no instruction in environmental medicine. And those that do offer an average of less than 10 hours of instruction over four years. Two-thirds of deans report “minimal” emphasis on environmental medicine. The trend is similar in residency programs.

What’s more, physicians report a low level of self-confidence in taking environmental histories, discussing such exposures with parents, and finding appropriate diagnosis and treatment resources. Generally, the pediatricians also report having low expectations that they could take environmental histories that would yield useful information. This corresponds to what traditional human behavioral models would predict—that doctors who expect environmental histories to be a useful tool are more likely to feel more confident about taking them.

Clinicians who do routinely take environmental histories seldom probe into parents’ exposures, the survey revealed. Moreover, the exposures physicians ask about are generally limited to lead and environmental tobacco smoke, according to earlier studies cited in the article. The survey did not address how frequently pediatricians may be misdiagnosing their patients as a result of failure to take a proper history or act appropriately on information supplied by a patient or parent.



More knowledge for better medicine. A survey of pediatricians reveals inadequate training on taking environmental histories and using environmental data in diagnosing and treating children.

Besides whether and how pediatricians take environmental histories, the researchers also collected information on training and information sources. The American Academy of Pediatrics stands out as the leading source of environmental health information. The pediatricians prefer newsletters and government publications over professional journals and Internet resources. However, pediatricians using the Internet rely on professional organization sites almost twice as often as commercial medical information portals, the survey found.

Nearly 90% of the physicians surveyed say they would like to learn more about children’s environmental health hazards. At the same time, physicians see “few logistic barriers, such as time, effort, or cost, to incorporating the environmental history into their clinical visits,” the researchers reported. Frumkin acknowledges, however, that the survey may overstate the pediatricians’ enthusiasm, because the response rate of just 56% may indicate some selection bias toward physicians who are already eager to learn more about environmental health.

Still, the survey “provides a data-based argument for beefing up education,” Frumkin says. He believes this could be helped by the creation nationwide of more Pediatric Environmental Health Specialty Units, which are funded by the Agency for Toxic Substances and Disease Registry. The handful of existing centers were set up in recent years to provide quality care for children and to increase the knowledge base of pediatric environmental medicine by providing a forum for sharing information, training, consultation, and clinical referrals. —Julie Wakefield